

Determinants of Household Food Insecurity in Northern Ghana: An Ordered Probit Approach

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Abstract

Even though food insecurity is experienced in different degrees, and in many forms and periods, most studies have often classified food insecurity as mild/very low, moderate/low and severe. This study extends the study on food insecurity by examining the relative occurrence of each of these wide categories using ordered probit model and analysing data from 4,288 households in northern Ghana. The study shows that for each of these categories, households' rural dwelling, age, land size and access to credit significantly increase food insecurity whilst maize crop output and marital status decrease food insecurity. This study reveals that food insecurity is a rural and productivity problem and not a poverty issue (or inadequate credit). We therefore recommend that credit in the form of inputs such as fertiliser, improved seed and mechanisation should be promoted rather than increasing access to credit (cash) to increase household members purchasing power.

Keywords: Northern Ghana, Ordered Probit, Productivity, Rural, Credit, Food Insecurity

1. Introduction

Food security at the global level or developed economy does not guarantee food security in the developing nations. Moreover, food security at the national level does not guarantee food security at the household or even the individual level. Developing economies until recently have been strongly dominated by the agricultural sector. The agricultural sector is the major contributor to many developing countries' GDP after the tertiary sector, however, it is characterised by low productivity and restricted competitiveness. This is due to the fact that, the agricultural sector is patronised by smallholder scale production units and subsistence farmers who apply usually, basic equipment and low-level technology (Duffour, 2010). The agricultural sector serves several functions including: source of livelihood for most of the countries population; source of raw materials for industries; a major foreign exchange earner and the main source of food security for the countries.

Considering the enormous contribution of agriculture to the country, there are still problems of food insecurity especially among households in developing countries. They are various meanings and definitions of food insecurity. In this research, it is considered as a situation when all people, lack physical and economic access to adequate, nutritious and safety food to meet their dietary needs and food preferences for a healthy and active living standard (FAO 1996). Globally, the number of people suffering from hunger and poverty is more than one billion, which represents one-seventh of the world's population (FAO 2009). The 1970s understanding of food security as a supply problem has since been contested. Sen (1981) asserts that food insecurity is more of a demand issue that affects poor people's access to food, than a supply phenomenon, affecting availability of food at the national level. According to Smith et al. (2000), the national food availability has a weak linkage to food insecurity at the regional and district levels. Food security was defined at the 1996 World Food Summit as "people at all times, having physical, social and economic access to adequate, nutritious and safety food which meets the dietary wants and food preferences for an active and healthy life" and includes stability and utilisation. According to the World Food Summit definition, food security has four different characteristics (availability, access, utilisation and stability) which are classified as indicators. The key determinants or indicators (availability and access) are considered to be the structural conditions that worsen or improve food security whilst outcome indicators (utilisation) show results in terms of inadequate food consumption or anthropometric weaknesses.

The Government of Ghana and development partners make efforts to improve the infrastructure level, reduce unemployment to the minimum level and eradicate poverty in the various regions of the country, especially, Northern Ghana. However, most of the population in Northern Ghana (Upper East, Upper West, Northern and part of Brong Ahafo Regions) remain undernourished due to either the non-availability of food or the absence of the economic resources to get access to nutritious food that meets their energy dietary requirement. Statistics indicate that, more than 680,000 people in Northern Ghana are considered to be either severely or moderately food insecure, out of the food insecure, 140,000 are classified as severely food insecure, having a very poor diet which comprises of just staple foods, little vegetables and insignificant oil. The Upper East Region has the highest percentage of households who are either severely or moderately food insecure (28%). In the Northern and Upper West regions 10% and 16% of households respectively, are either severely or

moderately food insecure. The five districts in Ghana with the highest percentage of households who are either severely or moderately food insecure are Wa West (42%), Central Gonja (39%), Talensi-Nabdam (39%), Kassena-Nankana West (35%) and Kassena-Nankana East (33%). These districts are in the Northern part of Ghana.

Food insecurity is one of the most critical public health constraints. Fighting food insecurity and its associated consequences require an understanding and knowledge of the factors that enhance food insecurity (Gundersen and Garasky, 2012). Despite the fact that food insecurity and hunger are the trickle-down of financial resource constraint, the usual income and poverty measurements do not provide clear and enough evidence and/or information about food insecurity. In fact, empirical analysis of food security data indicates that many low-income households appear to be food secure and small percentage of middle and high income households appear to be food insecure (Bickel et al. 2000). With all the illustrated validity of the food security intensity, there is limited available study that has employed food security scales to determine the socio-demographic characteristics that determine household food insecurity at the household level in Northern Ghana. This study precisely addresses that gap in the existing literature. It is important to notice that a clear understanding of the factors that enhance food insecurity can improve the framework of future agricultural and development policies aimed at uplifting household food security and child nutrition standard.

Food insecurity in Northern Ghana is largely attributed to two broad causes: general poverty and poor agricultural performance. This research is not attempted to address the multiple underlying causes of poverty, but rather to identify the social-demographic factors that determine the level of food insecurity in Northern Ghana.

2. Literature Review

2.1 Concepts of Food Security

The problem of food security is multifactorial. Within a household, food insecurity should be understood as a constrain of 1) food availability, 2) food access, and 3) food consumption (Consejo Nacional de Evaluación de la Política de Desarrollo Social CONEVAL, 2010). Food security is a concept that has evolved over time. Different perspective leads to many definitions and conceptual models on how household food security has been presented (Smith *et al.*, 2000). Statistics indicates about 200 definitions and 450 indicators of food security (Hoddinott, 1999). In Africa, the early 1970s food crises raised a major concern regarding supply shortfalls as a result of production failures due to drought and desert encroachment which was brought to the attention of the international donor community (Maxwell, 1992). In 1983, FAO asserts that, assessing food access, leads to the analysis of the balance between the demand and supply side of the food security equation: “Ensuring equivalent in both physical and economic access to the basic food to all people at all times to satisfy human need” (FAO, 1983). In the World Bank (1986) report, it is elaborated that poverty and hunger is a key concept of food security. In addition, food security is known in terms of: ‘All people access to adequate food for an active and healthy life at all time’. World Food Summit organised in the year 2000 shows that, 192 countries agreed and adopted a still more complex definition: ‘Food security, at the individual, household, national, regional and global levels. Food security is achieved when all people, at all times, have physical and economic access to adequate, nutritious and safety food to meet their dietary wants and food likes for an active and healthy life’ (FAO, 1998). This definition combines stability, access to food, availability of nutritionally adequate food and food utilisation. As a result, a synthesis of these definitions, with the main emphasis on availability, access, and utilisation, serves as a working definition in projects of international organizations.

2.2 Food Security Components

Common to most definitions of food security are the elements of availability, access, utilisation and stability or sustainability.

Availability

In this research, availability refers to the physical existence of food, be it from own production or on the markets. National level food availability is directly related to the combination of domestic food stocks, commercial food imports, assisted food, and domestic food production, as well as the underlying determinants of each of these factors. The use of the term availability is usually not clear, since it can refer to food supplies available at both the household level and at the national (aggregate) level. However, the term is applied most popularly to food supplies at the regional or national level (Riely *et al.*, 1999). The national food supply is a function of both demand-side and supply-side variables as derived in the food availability theoretical framework below:

Theoretical framework for food availability

The food availability theoretical framework of this study is adopted from Fosu and Heerink (2009). At the national level, total food supply is the sum of domestic food production (Q_{dfp}), food imports (Q_f), food aid (Q_a) and carryover stock (Q_{st}). Thus, aggregate food production or supply (Q_{afp}) is given as:

$$Q_{afp} = Q_{dfp} + Q_{fi} + Q_a + Q_{st} \dots\dots\dots 1$$

The quantity of food imported into a country dependent on price of world food (P_{wf}), per capita income (PKY) of the importing country, cost and availability of off-shore financing (proxy by international interest rate, IIR) and exchange rate (ER). Quantity of imported food is given as:

$$Q_{fi} = f(P_{wf}, PKY, IIR, ER)$$

$$\text{Where } \frac{\partial Q_{fi}}{\partial P_{wf}} < 0, \frac{\partial Q_{fi}}{\partial PKY} < 0, \frac{\partial Q_{fi}}{\partial IIR} < 0, \frac{\partial Q_{fi}}{\partial ER} < 0 \dots\dots\dots 2$$

On the other hand, quantity of food that is supplied domestically is a function of factor inputs, technology, quantity of infrastructural services and weather as expressed in equation (3):

$$Q_{dfp} = f(L, AL, K, F, AC, VFC, IS, W) \dots\dots\dots 3$$

Where L is units of labour, AL is acres of land, K is capital, F is fertiliser, AC is agrochemicals, VFC is improved varieties of food crops, IS is the quantity of infrastructural services and W denotes weather. The objective is to maximize profit. The revenue from farming and the cost associated with farming are specified in equations (4) and (5) respectively:

$$R = P_f Q_{dfp} \dots\dots\dots 4$$

$$AC = C(Q_{dfp}, X_l, X_{al}, X_k, X_f, X_{ac}, X_{vfc}, X_i, X_{is}) \dots\dots\dots 5$$

The profit function represents as:

$$\text{Max } \Pi = P_f Q_{dfp} - C(Q_{dfp}, X_l, X_{al}, X_k, X_f, X_{ac}, X_{vfc}, X_i, X_{is}) \dots\dots\dots 6$$

where $X_l, X_{al}, X_k, X_f, X_{ac}, X_{vfc}, X_i, X_{is}$ denote prices of labour, capital, land, fertiliser, agrochemicals, improved varieties of food crops, irrigation services and infrastructural services, respectively. The first-order condition ($\frac{\partial \Pi}{\partial Q}$) of equation (6) produces domestic food availability as expressed in equation (7) where P_f is the

price of food. The domestic food availability function is convex in the price of food and weather. That means as food prices increase the incentive to supply more food increases. Also, favourable weather improves cultivation conditions and this helps enhance domestic supply. However, domestic food supply is concave in input prices:

$$Q = Q_{dfp} = f(P_f, XL, XAL, XK, XF, XAC, XVFC, XIS, XW).$$

$$\frac{\partial Q}{\partial P_f} > 0, \frac{\partial Q}{\partial r_i} < 0, i(= L, AL, K, F, AC, VFC, IS), \frac{\partial Q}{\partial X} > 0 \dots\dots\dots (7)$$

Food aid import is exogenously determined, but the carry over stock is dependent on domestic interest rate. The food aid imports and carry over stock equations are represented by equations (8) and (9) respectively:

$$Q_a = AL \dots\dots\dots (8)$$

$$Q_{st} = f(DIR), \frac{\partial Q_{st}}{\partial DIR} < 0 \dots\dots\dots (9)$$

The next stage involves the substitution of equations (2), (7), (8) and (9) into equation (1). The resulting model, equation (10), is the total national food supply which is a function of both demand-side and supply-side variables:

$$Q_{afp} = Q_{df}(P_f, r_i, X) + Q_{fi}(P_{wf}, PKY, ER, IIR) + AL + Q_{st}(DIR) \dots\dots\dots (10)$$

Access

Access is the ability of having enough resources to obtain appropriate foods for a nutritious diet and healthy living. It is the diverse ways categories of people can obtain the available food. Usually, many have access to food through a combination of home-made/production, purchase from domestic, direct exchange of goods, gifts, borrowing or food aid and importation. Accessibility of food is guaranteed when all individuals within household who live in community have adequate resources, for instant cash, to obtain appropriate foods for a nutritious diet and healthy life (Riely *et al.*, 1995). Food access largely depends on; availability of household income, the share of household income to members, the price of food, and other factor that critically determine the individuals' physical accessibility to market, social and institutional benefit.

Utilisation

Utilisation is categorised into socio-economic and a biological aspect. The existence of sufficient and nutritious food availability and accessibility to the household leads to the decisions concerning what food is being

consumed (demanded) and how the food is allocated to the household members. Discriminatory distribution to household members where the aggregate access to food is sufficient usual lead to some individuals' suffering the deficiency of food security.

Stability

Stability refers to the duration through which nutrition and healthy food is secured (i.e. the time span within which food security is being considered). In much of the food security literature, a distinction is drawn between chronic food insecurity—the inability to meet food wants on an ongoing basis—and transitory food insecurity when there is no ability to meet food wants in a temporary nature (Maxwell and Frankenberger, 1992).

2.3. Factors affecting Food Security

Factors that affect household food security in various developing countries, especially in Africa and West African countries have been documented. The factors or determinants are most often varied based on location - different study areas were found to have variant attributes as food security determinants with some attributes recurring. A research by Oluwatayo (2008) in Nigeria, which adopts a probit model, found out that sex of household head, educational level, age and income have positive effects on food security whereas household size has negative effects on household food security. A study in South Africa carried out by Sikwela (2008) using logistic regression model indicated that per aggregate production, fertilizer application, cattle ownership and access to irrigation have a positive influence on household food security whereas farm size and household size have negative influence on the food security status of household.

Intensive work done by Babatunde *et al.* (2007) on food insecurity in Nigeria, using cross sectional data of 94 sampled farm households in the year 2005. Employing the recommended calorie required method; the study revealed that 36% of the sampled population were food secure and 64% of the households were food insecure. Determining the Shortfall/Surplus index showed that the food secure households have 42% in excess of the recommended calorie intake, while the food insecure households have 38% shortage of the recommended calorie intake. Analysis using logistic regression model showed that household income, household size, educational status of household head and quantity of food obtained from own production were found to be influential factors of the farmers households food security status in Nigeria.

Aidoo *et al.* (2013) conducted a study in the Sekyere-Afram Plains District of Ghana using binary logistic model. The study revealed that farm size, off-farm income and credit access as having a significant positive effect on household food security while male and younger farmers were food insecure. The study, therefore, recommended improved access to credit and economic diversification of rural households to curb food insecurity at the household level.

3. Methodology

3.1 Data Set and Sample Size

This study employed household data from USAID's Feed the Future survey of four regions in Northern Ghana – Upper East, Upper West, Northern and parts of the Brong Ahafo regions. Technical support for the survey was provided by the US Department of Agriculture (USDA) and the United States Aid for International Development (USAID) to three agencies, the Ghana Statistical Survey (GSS), Institute of Social and Economic Research (ISSER), Monitoring, Evaluation and Technical Support Services (METSS) to undertake the survey.

The surveyed used multistage sampling procedures in selecting the Enumeration Areas (EAs) as well as households. In the first stage, probability sampling was employed to select two hundred and thirty EAs from all the EAs within zones classified as Zone of Influence (ZOI) based on the Ghana 2010 Population and Housing Census. The ZOIs were then put into two strata from which a total of 4600 households were selected.

In this study a total of 4288 households were sampled on the basis of complete data on the a priori household characteristics that influence farmers' food insecurity situation.

3.2 Analytical model

Relationships between food insecurity and household demographic and socioeconomic factors were examined using ordered probit model. Ordered probit is a generalization of the probit analysis to the case of more than two categorical outcomes of an ordinal dependent variable.

The dependent variable, Food Insecure, was ranked from the following list: Food Secure, Low Food Insecure and High Food Insecure.

Estimating the model using Ordinary Least Squares (OLS) will yield a biased and inconsistent results; hence the maximum likelihood of the ordered probit model of the relationship between farmers' characteristics and their food security levels.

Suppose the underlying relationship to be characterized is,

$$y_i = X_i\beta + \varepsilon_i \quad \dots\dots\dots (11)$$

Where y_i is the exact but unobserved dependent variable; X_i is the vector of independent variables, β is the vector of regression coefficients which we wish to estimate and ε_i is the error term such that ε_i is identically and independently distributed as $N(0; 1)$. Further suppose that while we cannot observe y^* , we instead can only observe the categories of response:

$$y = \begin{cases} 0 & \text{if } y^* \leq 0, \\ 1 & \text{if } 0 < y^* \leq \mu_1 \\ 2 & \text{if } \mu_1 < y^* \leq \mu_2 \end{cases} \dots \dots \dots (12)$$

Then the ordered probit technique will use the observations on y , which are a form of censored data on y^* , to fit the parameter vector β .

$$y = \beta_0 + \beta_1 LOCAL + \beta_2 HHS + \beta_3 AGE + \beta_4 EDUC + \beta_5 LSZ + \beta_6 GEND + \beta_7 CREDIT + \beta_8 MSTAT + \beta_9 OUT + \beta_{10} LANDT + \beta_{11} REG \dots (13)$$

Where LOCAL is the Locality (Rural=1, otherwise=0), HHS is household size, AGE is Age of household head (years), EDUC is the Education Status of the household head (Educated=1, otherwise=0), LSZ is Land size (acres), GEND is the sex of household head (Male=1, otherwise=0), CREDIT is access to credit (Have credit=1, otherwise=0), MSTAT is the marital status, OUT is the output of household head (kg), LANDT is Land tenure system (Self owned land=1, otherwise=0), and REG is the Regional Dummy.

4. Results and Discussion

4.1 Descriptive Statistics

Table 1 shows descriptive statistics of mean, minimum and maximum for variables that the research takes into account to analyse the food insecurity level of households in the Northern region of Ghana.

The descriptive statistics of households sampled indicate that 75% of the respondents live in rural areas with an average household size of 6 persons per household sampled. The households are largely headed by male (82%) and the respondents have an average age of 45 years. Also, 78% of the respondents are educated (have tasted formal education) and have an average land size of 2 acres. Access to credit by respondents is low (31%), whilst a high percentage of the respondents are also married (79%). In terms of land tenure system, 78% of the respondents own the land they use for agricultural production and the remaining 22% farm on either family land or jointly owned lands. The results further show an average maize output of 574kg per farmer (representing about 6 bags of the maxi bags). A high percentage of the respondents (59%) are from the Northern region of Ghana, 17% from the Upper East region, 13% from the Brong ahafo and the remaining 11% from the Upper West region.

Table 1: Descriptive Statistics of variables in the Models

Variable	Measurement	Obs	Mean	Std. Dev.	Min	Max
Locality	Rural=1	4288	0.751166	0.4323878	0	1
Household Size	Persons	4288	5.624067	3.330136	1	35
Age	Years	4288	44.6201	16.54058	18	100
Education Status	Educated=1	4288	0.7791511	0.4148672	0	1
Land Size	Acres	4288	2.411474	3.72353	0	100
Sex of Household Head	Male=1	4288	0.8227612	0.3819152	0	1
Credit Access	Have Credit=1	4288	0.306903	0.4612626	0	1
Marital Status	Married=1	4288	0.7933769	0.4049299	0	1
Land Tenure System	Self-owned=1	4288	0.5809235	0.4934655	0	1
Maize Output	Kg	4288	574.7808	1015.941	0	12500
Region:						
Upper West		4288	0.1070429	0.3092039	0	1
Upper East		4288	0.167444	0.3734154	0	1
Brong Ahafo		4288	0.1268657	0.3328613	0	1
Northern		4288	0.5986474	0.4902293	0	1

Source: Authors' calculation

4.2 Levels of Food Insecurity

Food Insecurity can be in various degrees; Mild, Moderate and Severe depending on the time period within which it is experienced. Mild Insecurity is classified as being food insecure within a relatively short period of time during the day or night (say, having to skip meals due to food insecurity). Moderate Insecurity happens for

either a whole day or a whole night without food whilst severe case refers to where a person goes the whole day and night without food of any kind.

The Table 2 indicates that 54% of the respondents do not experience Mild Food Insecurity, i.e they are able to meet and satisfy the three daily minimum requirements of food security, but experience food shortages slightly or having to skip a meal due to non-availability food. Though, some of the respondents encountered the problem of Mild Food Insecurity, analysis indicates that, 32% rarely experience it, 12% experience it sometimes and only 2% often experience this food insecurity situation. Moderate food insecurity is also experienced rarely by 28%, 10% experience it sometimes whilst less than 1% experiences it often. The most severe food insecurity is experienced by 17% of the respondents sometimes, 4% rarely experience it, while less than 1% of them also experience it.

Table 2: Distribution of the Food Insecurity among respondents.

Level of Food Insecurity	Occurrence	Frequency	Percentage
Mild Food Insecure	No	2328	54.29
	Rarely	1390	32.42
	Sometimes	497	11.59
	Often	73	1.70
Moderate Food Insecure	No	2598	60.59
	Rarely	1221	28.47
	Sometimes	439	10.24
	Often	30	0.70
Severe Food Insecure	No	3383	78.89
	Sometimes	713	16.63
	Rarely	182	4.24
	Often	10	0.23

Source: Authors' Calculation

4.3 Determinants of Food Insecurity

4.3.1 Mildly Food Insecurity

Mild Food Insecurity is defined based on households' response to the question of: In the last 4 weeks, has there ever been no food to eat of any kind in your dwelling? Further questions as to how often this occurs were ordered as: No (Food Secure), Rarely (1-2 times), Sometimes (3-4 times) and Often (more than 10 times).

Table 3 shows the determinants of mild food insecurity. The LR Chi-square (258.11) is significant at the 1% level indicating the goodness of fit of the ordered probit model in measuring the determinants of food insecurity.

The results show that being in a rural area, having large family size, and being an older person all decrease food security of households. The results imply that households in rural areas are less food insecure compared to their counterparts in the urban areas. This supports the existing studies and the notion that food insecurity is a rural problem. On the other hand, educated persons, being married, living in male-headed households, owning land and producing more kilogrammes of food crop (maize) decreases food insecurity whilst positively influencing the level of food security of persons.

Contrary to our expectation (Aidoo *et al.*, 2013), having a large farm size and access to credit also increases food insecurity. Larger farm owners are food insecure due to poor yield (kg per acre cultivated) resulting from inefficient farm management. Larger farms are difficult to manage compared to small farms and so if owners do not manage the farms well, the yield obtained would be lower. Also, larger farms are usually owned by families and do not get the needed investment that will improve its productivity. Access to credit enhances the farmers' level of food insecurity because of the nature of the credit obtained. Most farmers obtain credit in cash and are likely to spend the money on non-farm expenditures and household consumables. Therefore, credit in terms of inputs such as improved seeds, fertilisers and agricultural mechanisation is a better option at improving crop yield and reducing the threats of food security.

Table 3. Determinants of Mild Food Insecurity

Variable	Mild Food Insecurity							
	Food Secure		Rarely		Sometimes		Often	
	dy/dx	P>z	dy/dx	P>z	dy/dx	P>z	dy/dx	P>z
Locality	-0.097	0.00	0.046	0.00	0.041	0.00	0.010	0.00
Household size	-0.010	0.00	0.005	0.00	0.004	0.00	0.001	0.00
Age	-0.002	0.00	0.001	0.00	0.001	0.00	0.000	0.00
Education	0.031	0.06	-0.015	0.06	-0.013	0.06	-0.003	0.07
Land size	-0.003	0.32	0.001	0.32	0.001	0.32	0.000	0.33
Sex of head	0.011	0.59	-0.005	0.59	-0.005	0.59	-0.001	0.59
Credit Access	-0.029	0.05	0.014	0.05	0.012	0.05	0.003	0.06
Marital status	0.039	0.04	-0.019	0.04	-0.017	0.04	-0.004	0.04
Output	0.000	0.00	0.000	0.00	0.000	0.00	0.000	0.00
Land tenure	0.009	0.58	-0.004	0.58	-0.004	0.58	-0.001	0.58
Upper West	-0.117	0.00	0.056	0.00	0.050	0.00	0.012	0.00
Upper East	-0.155	0.00	0.074	0.00	0.066	0.00	0.015	0.00
Northern	0.000	0.99	0.000	0.99	0.000	0.99	0.000	0.99
Number of observations =		4288						
LR chi2(13) =		258.11						
Prob > chi ² =		0.0000						
Log likelihood =		-4227.1347						
Pseudo R ² =		0.0296						

Source: Authors' Calculation

The study also reveals that; northern Ghana is still battling with food insecurity despite being the largest producer of maize in Ghana. The Upper East region is relatively more food insecure (0.015%) than the Upper West region (0.012%).

4.3.2 Moderately Food Insecurity

This is defined as households' response to the question: In the last 4 weeks, did you or any household member go to sleep at night hungry? Further questions as to how often this occurs were ordered as: No (Food Secure), Rarely (1-2 times), Sometimes (3-4 times) and Often (more than 10 times). The Table 4 below indicates the results of the determinants of Moderately Food Insecurity.

Table 4. Determinants of Moderate Food Insecurity

Variable	Moderate Food Insecurity							
	Food Security		Rarely		Sometimes		Often	
	dy/dx	P>z	dy/dx	P>z	dy/dx	P>z	dy/dx	P>z
Locality	-0.118	0.00	0.063	0.000	0.049	0.000	0.006	0.000
Household size	-0.007	0.00	0.004	0.002	0.003	0.002	0.000	0.005
Age	-0.001	0.00	0.001	0.003	0.001	0.003	0.000	0.006
Education	-0.016	0.35	0.008	0.347	0.007	0.348	0.001	0.352
Land size	-0.009	0.00	0.005	0.000	0.004	0.000	0.000	0.001
Sex of head	0.017	0.38	-0.009	0.380	-0.007	0.380	-0.001	0.383
Credit Access	-0.049	0.00	0.026	0.001	0.021	0.001	0.002	0.003
Marital status	0.036	0.05	-0.019	0.050	-0.015	0.050	-0.002	0.059
Output	0.000	0.00	0.000	0.000	0.000	0.000	0.000	0.000
Land tenure	-0.026	0.09	0.014	0.089	0.011	0.089	0.001	0.099
Upper West	-0.178	0.00	0.095	0.000	0.074	0.000	0.009	0.000
Upper East	-0.263	0.00	0.144	0.000	0.108	0.000	0.011	0.000
Northern	-0.003	0.88	0.002	0.879	0.001	0.879	0.000	0.880
Number of observations =		4288						
LR chi2(13) =		428.90						
Prob > chi ² =		0.0000						
Log likelihood =		-3770.4985						
Pseudo R ² =		0.0538						

Source: Authors' Calculation

Table 4 shows how the variables determine moderate food insecurity. The results are similar to that in Table 3 except for educated persons and land tenure system. Being an educated person increases moderate food insecurity by 0.016% whilst land owners also experience food insecurity (moderate).

4.3.3 Severely Food Insecure

Respondents were classified as severely food insecure based on their response to the question: In the last 4 weeks, did you or any household member go a whole day and night without food of any kind? How often respondents experienced severe food insecurity were ordered as No (Food Secure), Rarely (1-2 times), Sometimes (3-4 times) and Often (more than 10 times) as in the cases above.

Table 5. Determinants of Severe Food Insecurity

Variables	Severe Food Insecurity							
	Food Secure		Rarely		Sometimes		Often	
	dy/dx	P>z	dy/dx	P>z	dy/dx	P>z	dy/dx	P>z
Locality	-0.066	0.000	0.045	0.000	0.019	0.000	0.002	0.005
Household size	-0.006	0.003	0.004	0.003	0.002	0.003	0.000	0.022
Age	-0.001	0.003	0.001	0.003	0.000	0.003	0.000	0.020
Education	0.013	0.343	-0.009	0.344	-0.004	0.344	0.000	0.360
Land size	-0.005	0.025	0.003	0.026	0.001	0.026	0.000	0.058
Sex of head	-0.002	0.906	0.001	0.906	0.001	0.906	0.000	0.906
Credit Access	-0.043	0.001	0.029	0.001	0.012	0.001	0.001	0.015
Marital status	0.035	0.028	-0.024	0.028	-0.010	0.029	-0.001	0.062
Output	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.004
Land tenure	-0.014	0.283	0.010	0.284	0.004	0.284	0.000	0.306
Upper West	-0.221	0.000	0.151	0.000	0.064	0.000	0.005	0.001
Upper East	-0.199	0.000	0.136	0.000	0.058	0.000	0.005	0.001
Northern	-0.090	0.000	0.059	0.000	0.028	0.000	0.003	0.014
Number of observations =		4288						
LR chi2(13) =		227.42						
Prob > chi ² =		0.0000						
Log likelihood =		-2603.0978						
Pseudo R ² =		0.0419						

Source: Authors' Calculation

The table 5 indicates the results of the determinants of Severe Food Insecurity. The results are similar to the one in Table 3 except for sex of household head and land tenure. The results dispute the fact that living in male-headed household decreases food insecurity and agree with the findings in Table 3 that owners of land experience severe food insecurity.

5. Conclusions and Recommendations

This study examined the determinants of food insecurity and the degree to which the factors influence the level of food insecurity of households in Northern Ghana using a sample of 4,288 households. The results of the ordered probit models indicate that locality (living in rural areas), household size, age, land size and access to credit significantly increase households' level of food insecurity. On the other hand, marital status and maize crop output significantly reduce households' level of food insecurity. It was also revealed that; the northern sector is still food insecure despite producing a high percentage of the food crops in the country.

In order to address the food insecurity cancer, it is recommended that the government and other civil society organisations take drastic steps towards improving agricultural productivity. This can be done by intensifying extension service provision to farmers and encouraging farmers to use fertilizer, improved seed varieties and other modern farming practices that can overcome the effects of climate change and degrading soil fertility. Credit given to farmers should be in the form of improved seeds, fertilisers, and agricultural mechanisation at relatively affordable rates. This will improve farm investments and improve crop productivity, and consequently, reduce food insecurity amongst rural households.

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Appendices

Appendix 1a: Ordered Probit Results of Mild Food Insecurity in Northern Ghana

Mild Food Insecurity	Coef.	Std. Err.	Z	P>z	[95% Conf.Interval]	
Rural	0.2490944	0.0439821	5.66	0.000	0.162891	0.3352977
Household size	0.0264418	0.0060417	4.38	0.000	0.0146004	0.0382832
Age	0.0044767	0.0011162	4.01	0.000	0.0022891	0.0066643
Educated	-0.0802112	0.043233	-1.86	0.064	-0.1649462	0.0045239
Land Size	0.0073596	0.0074524	0.99	0.323	-0.0072469	0.0219661
Male	-0.0281191	0.0514799	-0.55	0.585	-0.1290178	0.0727797
Credit	0.0754654	0.0386942	1.95	0.051	-0.0003739	0.1513046
Married	-0.1013984	0.0485477	-2.09	0.037	-0.1965501	-0.0062467
Output	-0.0223383	0.0402696	-0.55	0.579	-0.1012654	0.0565887
Self	-0.0001781	0.0000275	-6.47	0.000	-0.000232	-0.0001241
Upper West	0.3008634	0.0738256	4.08	0.000	0.1561679	0.445559
Upper East	0.3969144	0.0663635	5.98	0.000	0.2668443	0.5269844
Northern	-0.0006416	0.059063	-0.01	0.991	-0.1164029	0.1151197
/cut1	0.5099209	0.0944126			0.3248757	0.6949661
/cut2	1.555265	0.0964447			1.366237	1.744293
/cut3	2.580586	0.1051408			2.374514	2.786658
Number of observations = 4288						
LR chi2(13) = 258.11						
Prob > chi ² = 0.0000						
Log likelihood = -4227.1347						
Pseudo R ² = 0.0296						

Appendix 1b: Ordered Probit Results of Moderate Food Insecurity in Northern Ghana

Moderate Food Insecurity	Coef.	Std. Err.	Z	P>z	[95% Conf.Interval]	
Rural	0.320494	0.0463259	6.92	0.000	0.2296969	0.4112912
Household size	0.01932	0.006225	3.10	0.002	0.0071194	0.0315207
Age	0.0034858	0.0011577	3.01	0.003	0.0012168	0.0057549
Educated	0.0426485	0.0453834	0.94	0.347	-0.0463012	0.1315983
Land Size	0.0255355	0.0067377	3.79	0.000	0.0123299	0.0387412
Male	-0.0469494	0.0534075	-0.88	0.379	-0.1516262	0.0577274
Credit	0.1347666	0.0400463	3.37	0.001	0.0562774	0.2132558
Married	-0.0988329	0.0502578	-1.97	0.049	-0.1973365	-0.0003294
Output	-0.0002199	0.0000296	-7.43	0.000	-0.0002779	-0.0001619
Self	0.0714298	0.0419818	1.70	0.089	-0.0108531	0.1537126
Upper West	0.4860566	0.0768142	6.33	0.000	0.3355034	0.6366097
Upper East	0.7041944	0.0692282	10.17	0.000	0.5685096	0.8398793
Northern	0.0095188	0.0627858	0.15	0.879	-0.113539	0.1325767
/cut1	0.9072095	0.0989787			0.7132149	1.101204
/cut2	1.937446	0.1016279			1.738259	2.136633
/cut3	3.216034	0.1200855			2.980671	3.451397
Number of observations = 4288						
LR chi2(13) = 428.90						
Prob > chi ² = 0.0000						
Log likelihood = -3770.4985						
Pseudo R ² = 0.0538						

Appendix 1c: Ordered Probit Results of Severe Food Insecurity in Northern Ghana

Severe Food Insecurity	Coef.	Std. Err.	Z	P>z	[95% Conf.Interval]	
Rural	0.2389236	0.0543358	4.40	0.000	0.1324273	0.3454199
Household size	0.020845	0.0070096	2.97	0.003	0.0071065	0.0345836
Age	0.003935	0.0013277	2.96	0.003	0.0013328	0.0065373
Educated	-0.0489266	0.0516408	-0.95	0.343	-0.1501407	0.0522875
Land Size	0.0177516	0.0079539	2.23	0.026	0.0021621	0.033341
Male	0.0074024	0.0626567	0.12	0.906	-0.1154024	0.1302072
Credit	0.1545144	0.0459343	3.36	0.001	0.0644848	0.244544
Married	-0.1277525	0.0580943	-2.20	0.028	-0.2416152	-0.0138898
Output	-0.0001545	0.0000334	-4.62	0.000	-0.00022	-0.000089
Self	0.0520853	0.0485739	1.07	0.284	-0.0431179	0.1472885
Upper West	0.8007023	0.0933101	8.58	0.000	0.6178179	0.9835867
Upper East	0.7241353	0.0868306	8.34	0.000	0.5539505	0.8943202
Northern	0.3351562	0.0808213	4.15	0.000	0.1767493	0.493563
/cut1	1.625046	0.1199355			1.389976	1.860115
/cut2	2.563908	0.1241896			2.320501	2.807315
/cut3	3.732598	0.1600299			3.418945	4.046251
Number of observations =	4288					
LR chi2(13) =	227.42					
Prob > chi ² =	0.0000					
Log likelihood =	-2603.0978					
Pseudo R ² =	0.0419					